FRICTION SHEET FEEDING MACHINE WITH REVERSIBLE DRIVEN RETARD ROLLER

FIELD OF INVENTION

[0001] The invention relates to friction sheet feeding machines for feeding individual sheets from a stack of sheets. More particularly, the invention relates to gating systems on friction sheet feeding machines.

BACKGROUND

[0002] A wide variety of friction sheet feeding machines are available for feeding individual sheets from the bottom of an essentially vertical stack of sheets. These machines typically include (i) a tray for holding a stack of sheets in an essentially vertical position, (ii) a nip for feeding a lowermost sheet from the stack, (iii) a driven friction roller or belt for contacting the downward facing major surface of the lowermost sheet in the stack and pulling the lowermost sheet from underneath the sheet stack towards the nip, and (iv) a friction retard surface positioned above the driven friction roller for contacting the leading edge(s) and any exposed upward facing major surface(s) of the sheet(s) positioned directly above the lowermost sheet for retarding advancement of the sheet(s) directly above the lowermost sheet and thereby facilitating separation of the lowermost sheet from the immediately overlying sheet prior to introduction of the lowermost sheet into the feed nip.

[0003] Friction retard surfaces having a wide variety of sizes, shapes, contours, coefficient of friction, etc., have been employed over the years. Rotating friction retard rollers have also been employed, with the retard roller rotated in a forward direction on some machines and rotated in a reverse direction on others. While a forward rotating friction retard roller provides significant advantages when feeding certain types of sheets, such as coarse flat product, and a reverse rotating friction retard roller provides significant advantages when feeding other types of sheets, such as coated, glossy, printed product, the direction of rotation limits the types of sheets which may be reliably fed through the friction sheet feeding machine.

[0004] Accordingly, a need exists for a friction sheet feeding machine capable of providing the advantages associated with a rotating friction retard roller without the limitations also associated with a rotating friction retard roller.

BRIEF DESCRIPTION OF THE DRAWINGS

[0005] Figure 1 is a front perspective view of one embodiment of the invention.

[0006] Figure 2 is a partial side of the machine shown in Figure 1 with the side panel removed to facilitate viewing of internal components.

[0007] Figure 3 is a front perspective view of one embodiment of the gating assembly and height adjustment assembly shown in Figure 1.

[0008] Figure 4 is a side view of the gating assembly and height adjustment assembly shown in Figure 3.

[0009] Figure 5 is an exploded view of the gating assembly and height adjustment assembly shown in Figure 3.

SUMMARY OF THE INVENTION

[0010] The invention is a friction sheet feeding machine which includes a tray, a driven friction feed roller, and a driven friction retard roller. The tray is effective for holding a stack of sheets in a substantially vertical position. The friction feed roller is configured and arranged relative to the tray for contacting the downward facing major surface of a lowermost sheet in a stack retained within the tray and pulling the lowermost sheet from underneath the stack. The friction retard roller is vertically spaced in parallel relationship above the friction feed roller for contacting the leading edge and any exposed upward facing major surface of the sheet immediately overlying the lowermost sheet so as to retard advancement of the overlying sheet, wherein driven rotation of the friction retard roller is reversible as between a

concurrent direction relative to the friction feed roller when in a first state and a countercurrent direction relative to the friction feed roller when in a second state.

DETAILED DESCRIPTION OF THE INVENTION INCLUDING A BEST MODE

Nomenclature

010	Friction Sheet Feeding Machine
020	Frame
021	Base Plate
022	First Side Panel
023	Second Side Panel
025	Cross Member
026	Support Rods
026a	First Support Rod
026b	Second Support Rod
026c	Third Support Rod
026d	Fourth Support Rod
040	Tray Assembly
041	Floor of Tray Assembly
100	Drive Assembly
120	Friction Feed Rollers
125	Idler Rollers
130	Friction Belt
140	Drive Belt
150	Conveyor System
151	Driven Conveyor Roller
152	Idler Conveyor Roller
153	Conveyor Belt
160	Drive Belt
200	Gating Assembly
210	Friction Retard Roller
211	Central Shaft
211g	Radial Groove on Central Shaft
212	Bearings
220	Auxiliary Electric Motor
220d	Drive Shaft of Auxiliary Electric Motor
221	Motor Mount
222	Machine Screws
223	Machine Screws
230	Switch
231	Slide Button on Switch
232	Switch Housing

233 Switch Mount
234 Switch Position Indicator Label
235 Machine Screws
236 Machine Screws
237 Connector
240 Protective Cover
241 Machine Screws
250 Mounting Base
251 First Support Arm
252 Second Support Arm
253 Machine Screws
254 Machine Screws
259 Bore in Mounting Base
260 Gear Assembly
261 First Spur Gear
262 Second Spur Gear
263 Third Spur Gear
264 Shaft Lock
265 Cover
266 Machine Screws
267 Bearing
268 Pin
271 Pull Knobs
271a First Pull Knob
271b Second Pull Knob
272 Set Screws
275 Ball Plunger
300 Height Adjustment System
310 Mounting Block
311 Machine Screws
319 Transverse Channel Through Mounting Block
320 Lift Shaft
320c Central Portion of Lift Shaft
320d Distal End of Lift Shaft
320p Proximal End of Lift Shaft
330 Dial
331 Insert
332 Threaded Shaft
333 Mounting Flange
334 Machine Screws
335 Dial Position Indicator
340 Cap Screw
351 Spring
352 Bearing
500 Stack of Sheets
S Individual Sheets
$\mathbf{S_{low}}$ Lowermost Sheet
$\mathbf{S_{over}}$ Overlying Sheet
$\mathbf{S_{lead}}$ Leading Edge of Sheets in Sheet Stack

Definitions

[0011] As utilized herein, including the claims, the phrase ***"concurrent direction,"*** when used to describe rotation of a roller relative to an neighboring parallel roller, means that the rollers are moving in the same direction at that point where the rollers are closest to one another (*i.e.*, one roller rotates clockwise while the other rotates counterclockwise).

[0012] As utilized herein, including the claims, the phrase ***"countercurrent direction,"*** when used to describe rotation of a roller relative to an neighboring parallel roller, means that the rollers are moving in opposite directions at that point where the rollers are closest to one another (*i.e.*, both roller rotate clockwise or both rollers rotate counterclockwise).

[0013] As utilized herein, including the claims, the term ***"releasable,"*** means capable of rapid (*i.e.*, averaging less than one minute) and repeated attachment and detachment by hand.

Construction

[0014] The friction sheet feeding machine **10** includes a frame **20**, a tray assembly **40**, a drive assembly **100**, a gating assembly **200**, and a height adjustment system **300**. The machine **10** is capable of serially feeding individual sheets **S** in a lateral direction (unnumbered) from the bottom (unnumbered) of a generally vertical stack **500** of sheets **S** retained within the tray assembly **40**.

[0015] As shown in FIG. 1, a suitable configuration for frame **20** is a generally rectangular frame **20** having (i) a generally horizontal base plate **21**, (ii) a first side panel **22** extending upward from the base plate **21**, (iii) a second side panel **23** also extending upward from the base plate **21**, (iv) a rear end plate (not shown) extending upward from the base plate **21** and laterally interconnecting the side panels **22** and **23**, (v) a lateral cross member **25** transversely spaced above the base plate **21** and interconnecting the side panels **22** and **23**, and (vi) a plurality of laterally extending support rods **26** extending between and interconnecting the side panels **22** and **23**. Other frame configurations may also be employed, such as a cross-beam construction rather than the plate construction shown in FIG. 1.

[0016] Tray assembly **40** is effective for holding a stack **500** of individual sheets S in a substantially vertical position with a slight biasing of at least the lower portion (unnumbered) of the stack **500** towards the friction feed roller(s) **120** and the friction retard roller(s) **210**.

[0017] One means for achieving the desired biasing of the stack **500**, shown in FIG. 1, is to incline the floor **41** of the tray assembly **40** towards the friction feed roller(s) **120** and the friction retard roller(s) **210**. Other means are known and may also be employed, such as a transversely extending strip (not shown) positioned within the tray assembly **40** for supporting the trailing edges (not shown) of the sheets S in the stack **500** wherein the lower portion (unnumbered) of the support strip is curved towards the friction feed roller **120** and the friction retard roller **210**.

[0018] Generally, drive assembly **100** includes a primary drive motor (not shown) and a friction feed roller(s) **120** driven by the primary drive motor. The friction feed roller(s) **120** can directly contact the sheets S or can be used to drive a friction belt **130** which contacts the sheets S.

[0019] Referring generally to FIGs 1 and 2, one embodiment of a suitable drive assembly **100** includes a primary drive motor (not shown), and a plurality of laterally aligned and laterally spaced friction belts **130** each mounted onto a driven friction feed roller **120** and an idler roller **125** wherein the idler rollers **125** are longitudinally aligned and longitudinally spaced with each associated friction feed roller **120**. The friction feed rollers **120** are mounted upon a laterally extending first support rod **26a** which is rotatably attached to the side panels **22** and **23** of the frame **20**. Similarly, the idler rollers **125** are mounted upon a laterally extending second support rod **26b** which is longitudinally spaced from the first support rod **26a** and also rotatably attached to the side panels **22** and **23** of the frame **20**. The first support rod **26a** is driven by the primary drive motor (not shown) via drive belt **140**.

[0020] The embodiment of the drive assembly **100** shown in FIGs 1 and 2 further includes a conveyor system **150** downstream from the friction belts **130** for receiving individual sheets S fed from the sheet stack **500** by the friction belts **130** and conveying the fed sheets S to the desired location, typically a conveyor belt (not shown) timed to receive and collate sheets S fed from several aligned friction sheet feeding machines **10**. The

conveyor system **150** shown in FIGs 1 and 2 includes a conveyor belt **153** mounted onto a driven conveyor roller **151** and an idler conveyor roller **152** wherein the idler conveyor roller **152** is longitudinally aligned with and longitudinally spaced from the driven conveyor roller **151**. The driven conveyor roller **151** is mounted upon a laterally extending third support rod **26c** which is rotatably attached to the side panels **22** and **23** of the frame **20**. Similarly, the idler conveyor roller **152** is mounted upon a laterally extending fourth support rod **26d** which is longitudinally spaced from the third support rod **26c** and also rotatably attached to the side panels **22** and **23** of the frame **20**. The third support rod **26c** is driven by the second support rod **26b** via drive belt **160**.

[0021] Gating assembly **200** includes a friction retard roller(s) **210** driven by an auxiliary electric motor **220** wherein the direction of rotation of the retard roller(s) **210** is reversible as between a forward (concurrent) direction and a reverse (counter current) direction so as to permit customized operation of the friction sheet feeding machine **10** to accommodate feeding of a wide variety of different sheets **S**. The ability to reverse the rotational direction of the driven friction retard roller(s) **210** allows the retard roller(s) **210** to rotate concurrently with the friction feed roller(s) **120** when in a first state and rotate countercurrent to the friction feed roller(s) **120** when in a second state.

[0022] Referring generally to FIGs 3-5, one embodiment of a suitable gating assembly **200** includes a pair of friction retard rollers **210** driven by an auxiliary electric motor **220** with the rotational direction of the auxiliary electric motor **220** controlled by a switch **230**, such as a DPDT slide switch.

[0023] The specific embodiment of a suitable gating assembly **200** shown in FIGs 3-5 includes an auxiliary electric motor **220** secured to a mounting base **250** by a motor mount **221**. The motor mount **221** is attached to the mounting base **250** by machine screws **222** and attached to the auxiliary motor **220** by machine screws **223**.

[0024] The retard rollers **210** are mounted upon a central shaft **211**. The central shaft **211** is rotatably supported upon bearings **212** between a first support arm **251** and a second support arm **252**. The first and second support arms **251** and **252** are secured to opposite ends (unnumbered) of the mounting base **250** by machine screws **253** and **254** respectively. The drive shaft **220d** of the auxiliary electric motor **220** is operably connected to the central shaft

211 upon which the retard rollers **210** are mounted by means of a gear assembly **260**. The gear assembly **260** includes a first spur gear **261** driven by the auxiliary electric motor **220**, a second spur gear **262** driven by the first spur gear **261**, and a third spur gear **263** driven by the second spur gear **262**. The first spur gear **261** is fixedly attached to the drive shaft **220d** of the auxiliary electric motor **220** by a shaft lock **264**, which is rotatably retained in position proximate the first support arm **251** by bearing **267**. The second spur gear **262** is rotatably mounted upon a pin **268** attached to the first support arm **251**. The third spur gear **263** is fixedly attached to the central shaft **211** by a set screw (not shown). The gears and other attendant components of the gear assembly **260** are positioned within recesses (unnumbered) provided in the first support arm **251**. A cover **265** is attached over the outside face (unnumbered) of the first support arm **251** by machine screws **266** to retain the gears and other attendant components of the gear assembly **260** in position.

[0025] The switch **230** is mounted within a switch housing **232** by means of a switch mount **233** and machine screws **235**. The switch housing **232** is secured to the second support arm **252** by machine screws **236**. The switch **230** is electrically connected to the auxiliary electric motor **220** by an electrical lead (not shown). A switch position indicator label **234** may be attached by machine screws **235** to the switch housing **232** alongside the slide button **231** of the switch **230** for indicating the rotational direction of the auxiliary electric motor **220** based upon the position of the slide button **231**.

[0026] Auxiliary electric motor **220** is electrically connected to a power source (not shown). Operation of the auxiliary electric motor **220** is preferably controlled by the main control system (not shown) for the friction sheet feeding machine **10** so that the retard rollers **210** are rotated by the auxiliary electric motor **220** only when the feed rollers **120** are rotated by the primary drive motor. This prevents the retard rollers **210** from continuing to rotate and potentially feeding and/or damaging sheets **S** stacked within the tray assembly **40** when sheets **S** are no longer being fed from the sheet stack **500** by feed rollers **120**.

[0027] Pull knobs **271** extend laterally from each side (unnumbered) of the gating assembly **200**, with a first pull knob **271a** proximate the gear assembly **260** and laterally offset from the cover **265**, and a second pull knob **271b** proximate the switch **230** and laterally offset from the switch housing **232**. The pull knobs **271** are connected to the ends (unnumbered) of the central shaft **211** by set screws **272**. A cavity (not shown) is provided

on the interior face (not shown) of the cover **265** in lateral alignment with the third spur gear **263**. The cavity is configured and arranged to accommodate the third spur gear **263** so as to permit the third spur gear **263** to be laterally displaced from engagement with the second spur gear **262** by pulling upon the first knob **271a** and/or pushing upon the second knob **271b**. Displacement of the third spur gear **263** from operable engagement with the second spur gear **262** allows an operator to disengage the retard rollers **210** from rotation by the auxiliary electric motor **220** and thereby allow in-use servicing of the friction sheet feeding machine **10** without requiring a complete shut down of the machine **10**. A ball plunger **275** is positioned within a longitudinal bore (not shown) in the second support arm **252**. The longitudinal bore extends into contact with the laterally extending orifice (unnumbered) in the second support arm **252** through which the central shaft **211** is rotatably retained. An outside radial groove **211g** is provided on the central shaft **211** for cooperatively and releasably engaging the ball plunger **275** when the central shaft **211**, and thereby the retard rollers **210**, are returned to the original desired laterally position within the gating assembly **200**.

[0028] A protective cover **240** can be attached to the top (unnumbered) of the first and second support arms **251** and **252** by machine screws **241** for covering the rotating components of the gating assembly **200**, including the drive shaft **220d** of the auxiliary electric motor **220**, the gear assembly **260**, the central shaft **211** and the retard rollers **210**.

[0029] The gating assembly **200** can be secured to the frame **20** by any suitable means for securely positioning the retard rollers **210** in proper lateral alignment with the feed rollers **120** with the desired transverse spacing or gap (unnumbered) between the retard rollers **210** and the feed rollers **120**. To accommodate the feeding of sheets **S** of different thickness, the gating assembly **200** is preferably secured to the frame **20** by a height adjustment system **300**, such as exemplified in FIGs 3-5.

[0030] Referring generally to FIGs 3-5, one embodiment of a suitable height adjustment system **300** includes (i) a mounting block **310** for fixed attachment of the height adjustment system **300** to the frame **20**, and (ii) a lift shaft **320** slidably engaged by the mounting block **310** with a distal end **320d** of the lift shaft **320** engaging the mounting base **250** of the gating assembly **200** and a proximal end **320p** attached to a dial **330**. The height adjustment system **300** is operable for transversely adjusting the position of the lift shaft **320** relative to the

mounting block **310** by rotation of the dial **330** and thereby adjusting the transverse position of the retard rollers **210** in the gating assembly **200** relative to the feed rollers **120**.

[0031] The specific embodiment of a suitable height adjustment system **300** for the gating assembly **200** shown in FIGs 1-5 includes a mounting block **310** capable of fixed attachment to the cross member **25** of the frame **20** by machine screws **311**. A transverse channel **319** of squared cross-section extends transversely through the mounting block **310**.

[0032] The lift shaft **320** is slidably engaged within the transverse channel **319**. The distal end **320d** of the lift shaft **320** passes through a transversely extending bore **259** in the mounting base **250** of the gating assembly **200**, with the mounting base **250** prevented from sliding off the lift shaft **320** by a cap screw **340** attached to the distal end **320d** of the lift shaft **320**. The mounting base **250** is biased against the cap screw **340** by a spring **351** positioned around the distal end **320d** of the lift shaft **320**. The proximal end **320p** of the lift shaft **320** is threadably engaged to a dial **330** by means of an insert **331** and a threaded shaft **332**, whereby rotation of the dial **330** is translated to transverse movement of the lift shaft **320** within the transverse channel **319** in the mounting block **310**. A central portion **320c** of the lift shaft **320** has a squared cross-section which mates with the transverse channel **319** in the mounting block **310** to prevent the lift shaft **320** from rotating when the dial **330** is rotated.

[0033] A mounting flange **333** can be secured atop the mounting block **310** between the dial **330** and the mounting block **310** by recessed machine screws **334**. The mounting flange **333** is designed to provide sufficient frictional contact with the dial **330** to prevent undesired vibrational rotation of the dial **330**. A dial position indicator **335** for indicating the height of the retard rollers **210** (*e.g.*, the size of the gap between the friction belt **130** and the retard rollers **210**) may be positioned atop the dial **330**. The dial **330** can be marked with a series of peripherally spaced marks (unnumbered) and the mounting flange **333** marked with a single peripheral mark (unnumbered) for purposes of indicating the currently selected position of the dial **330** as the marking on the dial **330** aligned with the marking on the mounting flange **333**.

[0034] A bearing **352** is preferably positioned around the distal end **320d** of the lift shaft **320** between the mounting block **310** and the mounting base **250**, with the bearing **352**

preferably recessed into the mounting block **310** and the biasing spring **351** pressed between the mounting block **310** and the bearing **352**.

Use

[0035] A stack **500** of sheets **S** is positioned upon the tray assembly **40** with the leading edges S_{lead} of the sheets **S** contacting the cross member **25**. A sheet alignment guide system (not shown) is typically employed to ensure that the stack **500** remains properly positioned and uniformly stacked throughout the feeding operation. Height adjustment dial **330** is rotated until the desired gap between the friction belt **130** and the retard rollers **210** is achieved, based primarily upon the physical characteristics of the sheets **S** in the stack **500** (*e.g.*, thickness and stiffness). Switch **230** is toggled to the desired direction of rotation (concurrent or counter current), again based primarily upon the physical characteristics of the sheets **S** in the stack **500** (*e.g.*, tackiness). Activation of the friction sheet feeding machine **10** permits friction feed rollers **120** and friction retard rollers **210** to simultaneously rotate to effect feeding of the lowermost sheet S_{low} from stack **500** by the friction belt **130** while the retard rollers **210** contact the overlying sheet S_{over} for purposes of preventing the overlying sheet S_{over} from feeding with the lowermost sheet S_{low} while positioning the overlying sheet S_{over} for subsequent feeding by the friction belt **130**.

[0036] The retard rollers **210** may be effectively rotated over a wide range of peripheral speeds. Generally, a peripheral speed of between about 2 cm/min to about 5 cm/min is preferred when the retard rollers **210** are rotated in a concurrent direction, and a peripheral speed of between about 2 cm/min to about 10 cm/min is preferred when the retard rollers **210** are rotated in a counter current direction. A peripheral speed of greater than about 5 cm/min in the concurrent direction tends to result in improper separation of product or multiple feeds, while a peripheral speed of less than about 2 cm/min. in the concurrent direction tends to result in uneven wear or flat spots on the retard rollers **210**. A peripheral speed of greater than about 10 cm/min in the counter current direction tends to damage the leading edge S_{lead} of sheets **S** while a peripheral speed of less than about 2 cm/sec in the counter current direction tends to result in uneven wear or flat spots on the retard rollers **210**.